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Reproducing a turbulent jet flow in a 3D periodic box GUILLAUME BLANQUART, K. JEFF RAH, CHANDRU DHANDAPANI, Caltech —
A triply periodic box is a useful computational geometry to create statistically steady turbulence. It is also convenient to perform a posteriori spectral analysis. However, it is difficult to produce a realistic turbulent flow inside the periodic box. In this current investigation, we aim to develop a method to produce triply periodic DNS whose turbulent properties resemble those of a realistic turbulent flow. The target realistic flow is an axisymmetric turbulent jet on its centerline. The mean velocity information of turbulent jets is applied to the momentum equation in physical space, which results in an anisotropic linear forcing term for a triply periodic box. This new forcing term is derived to replicate the turbulent characteristics of jets in a triply periodic box. Forcing schemes are not new and several have been proposed already for the simulations in spectral space and in physical space. Unfortunately, these methods are rather arbitrary; they prove to sustain the turbulence, but they were not derived to reflect real turbulent flows. In contrast, the new source term successfully reproduces the anisotropy, kinetic energy, and dissipation rate on the centerline of turbulent jets. The spectra of normalized dissipation also compare favorably against experiments.

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